Quantum Well Infrared Photodetectors for Astronomy

Michael Ressler, James Bock, Sumith Bandara, Sarath Gunapala, Michael Werner
Jet Propulsion Laboratory, California Institute of Technology

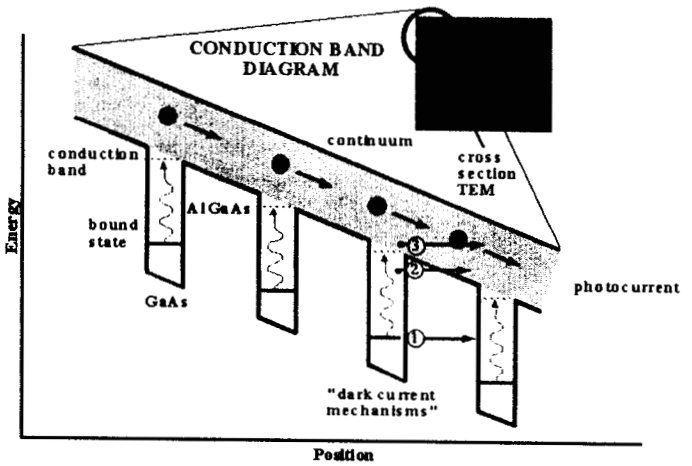
June 27, 2000

JPL

QWIP Properties

Realization of quantum wells in AlGaAs
Advantages:

- Tunable bandpass
  - 15 μm device for surveilance applications
  - 8.5 and 12.5 μm devices in QWICPIC, astronomical camera at Palomar
  - devices could be doped for far-IR wavelengths $\geq$ 70 μm
- Higher temperature operation
  - 25–30 K for low background applications
- Low 1/f noise
  - None measured to 30 mHz
- Easily mated to existing CMOS muxes
  - 640×480 already produced
  - 1024^2 in development

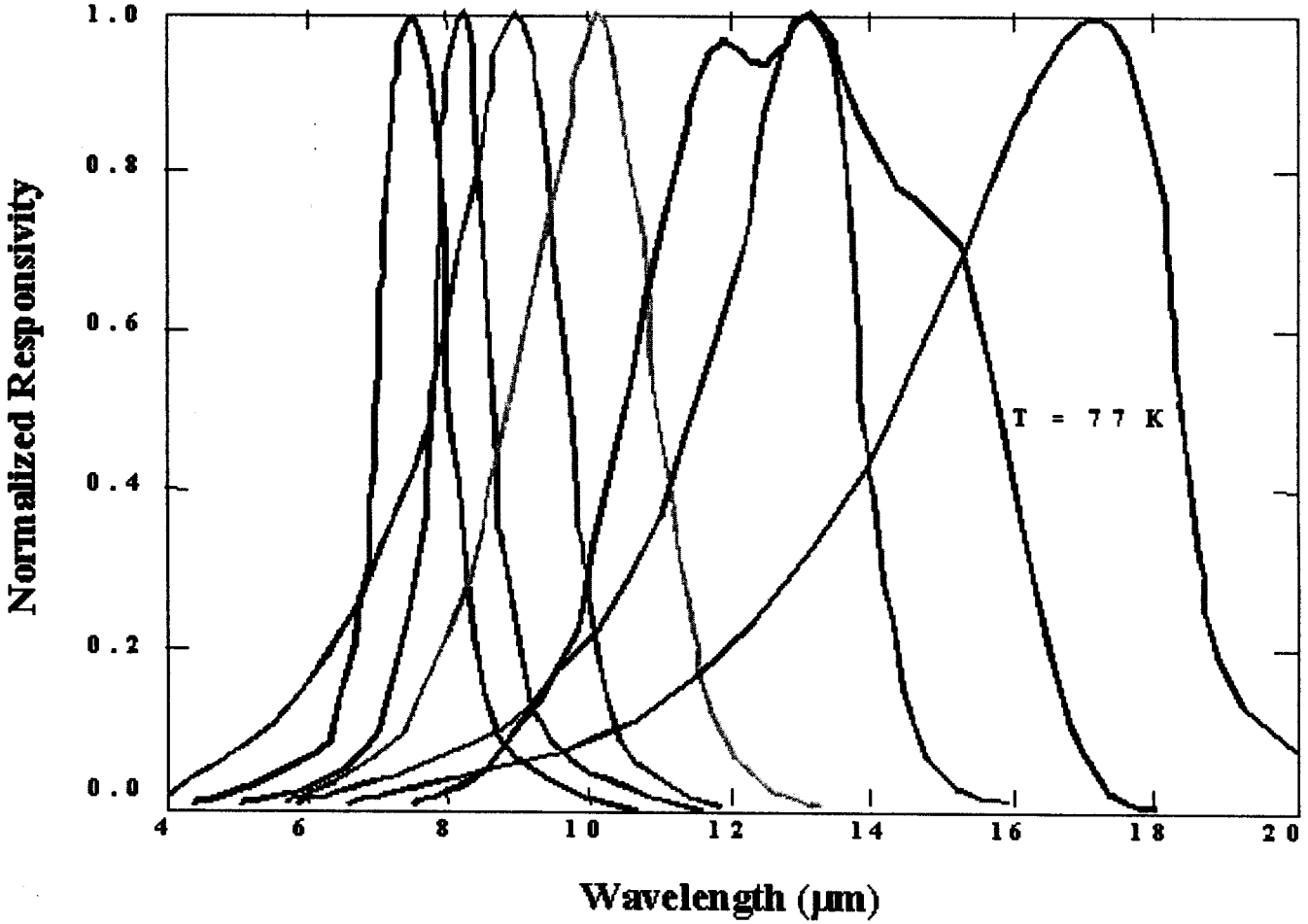


Disadvantages

- Narrowish bandwidth
  - 10% for typical structure
  - "broadband" devices still only 50%
- Modest quantum efficiency
  - Photons must enter || to surface
  - Diffusers mated to detector improve performance
  - Best QE's are of order 25%

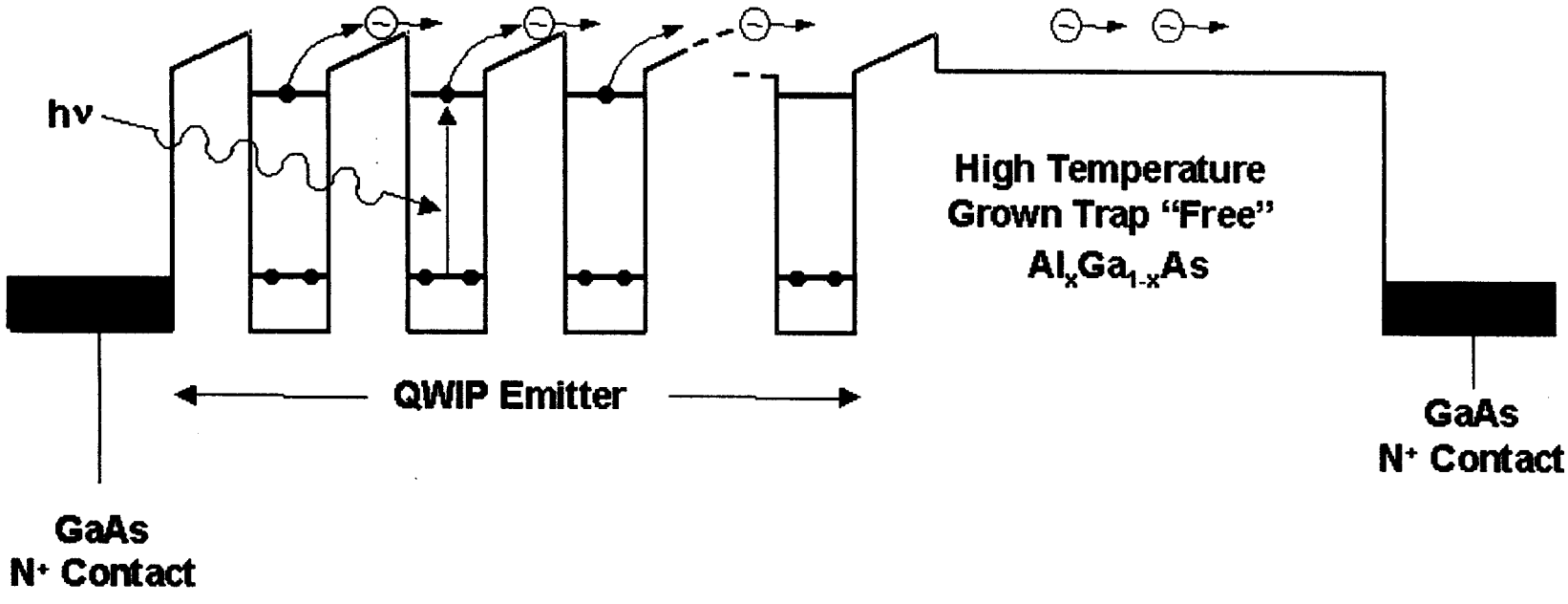
JPL

Spectral Response



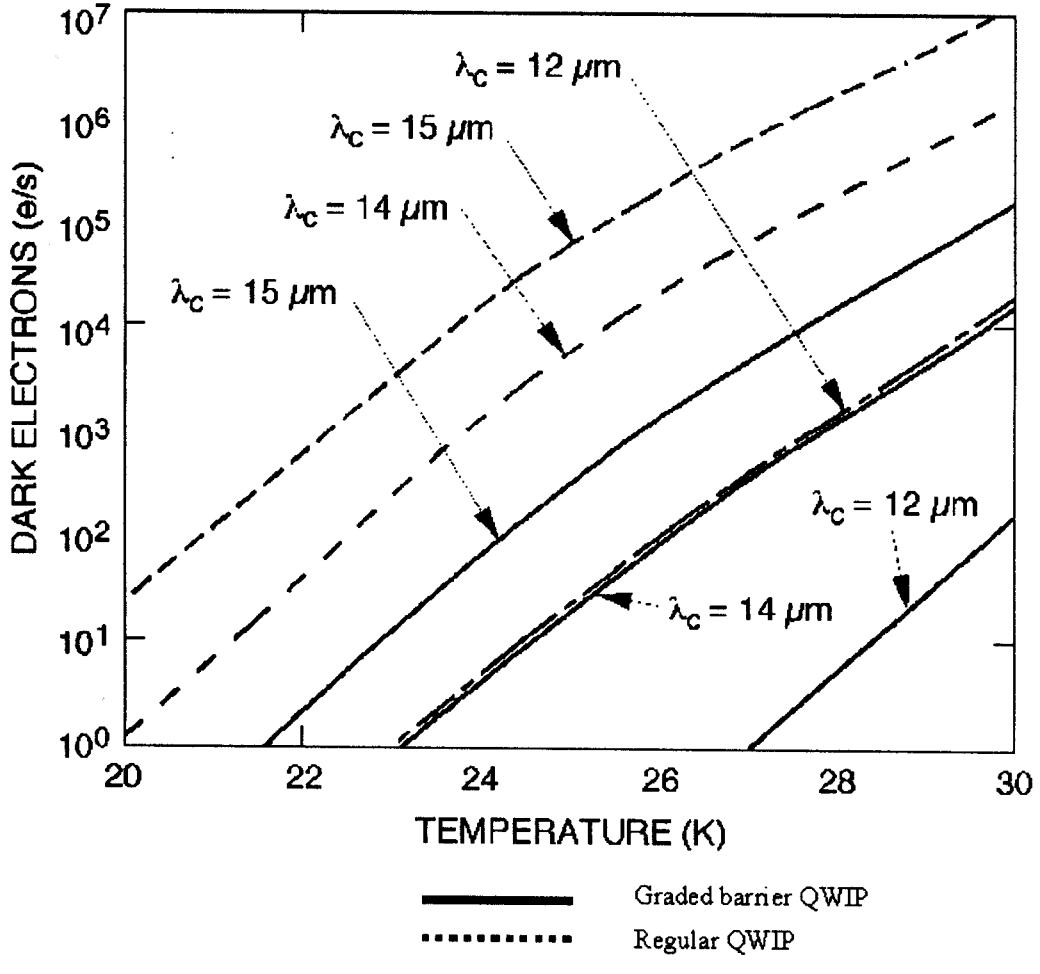
Spectral response of a suite of classical QWIPs along with a broadband version.

Overcoming Low Flux Problems



- Simple QWIPs suffer same electric field problems as photoconductors at very low backgrounds
- Solution: BIB-like structure, with trap-free blocking layer

Dark Current Properties



Estimated dark current properties of a 40 μm square pixel.

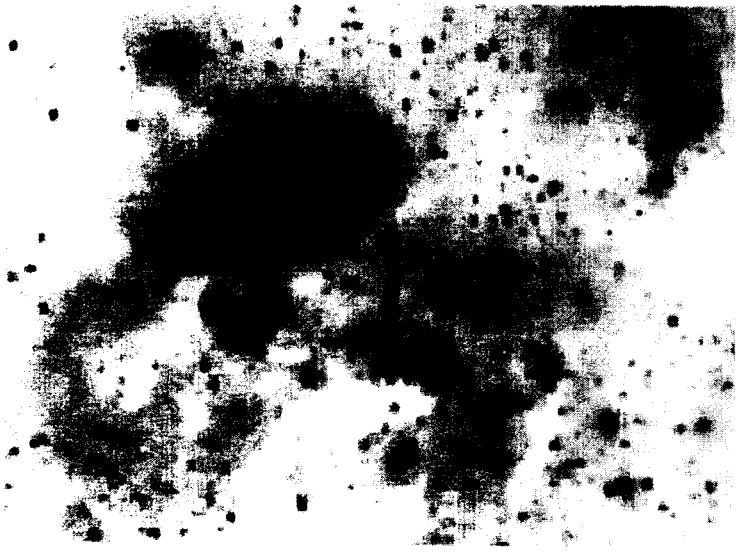
JPL

Orion Trapezium

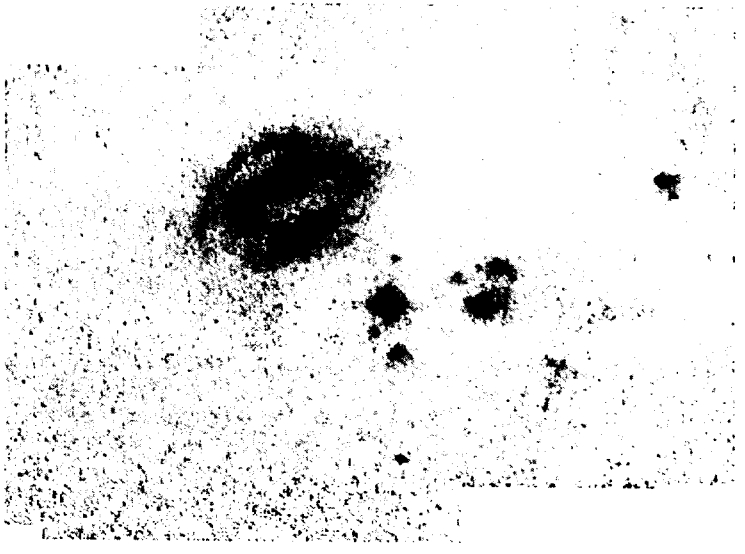
- QWICPIC has been at Palomar for 2 years.
- 256^2 8.5 μm QWIP
- Observations of high mass star forming regions
- Will soon install 12.5 μm 640×480 QWIP for dual-band imaging

JPL

W3 Star Forming Region



2 μm



8.5 μm

QWICPIC has provided detailed information about temperature structure in ionized areas in star forming region.

JPL

Summary

- QWIPs are a viable alternative when 10 K cooling is not available
- Tunable passbands can be optimized to mission
- Ultra low 1/f noise allows long, stable integrations
- Easily manufactured and can be scaled to large formats
- In production now, and working in an astronomical environment